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ABSTRACT

This report presents the results of a 1995-96 survey of U.S. colleges and universities offering doctoral, master's, and bachelor's degrees in physics and astronomy, focusing on degree production and current student enrollment. The survey found that first-year graduate student enrollments for 1996-97 declined by 2.5 percent from the previous year. Ph.D. production for 1995-96 (1,438) was down 3 percent from the high 2 years prior. Physics bachelor degree production continued to decline, with the class of 1995-96 totaling 4,156 degrees. Recently, attention has focused on master's programs in physics as a means of making physics students more marketable in the industrial work force. However, few master's programs offer such curriculum options as co-ops, internships, or interdisciplinary degrees. The 72 degree-granting astronomy departments conferred 126 doctorates and 181 bachelor's degrees on the class of 1995-96; these programs attract fewer foreign students and a larger proportion of women than their physics counterparts. The representation of minorities among physics degree recipients has not changed in recent years. At all degree levels, Hispanic and African-American students continue to be underrepresented, and Asian-Americans overrepresented. An appendix provides data on degree and enrollment trends over the last 10 years. (SW)

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ENROLLMENTS AND DEGREES REPORT

HIGHLIGHTS

- First-year graduate student enrollments for 1996-97 declined by 2.5% from the previous year's total. The now six-year decline in first-year graduate student enrollments has reached 27%.

- PhD production is starting to show signs of the impending decline. The total for 1995-96 (1,438) is down three percent from the recent high two years ago. Greater and sustained declines are anticipated in coming years.

- Physics bachelor's degree production continues to decline, with the class of 1995-96 totaling 4,156 degrees. This decrease in undergraduate degree production has been the greatest at departments that also have physics graduate programs.

- Recently attention has focused on master's programs in physics as a means of making physics students more marketable in the industrial work force. However, surprisingly few master's programs offer such curriculum options as co-ops, internships or interdisciplinary degrees.

- The 72 degree-granting astronomy departments conferred 126 PhDs and 181 bachelor's degrees for the class of 1995-96. These programs continue to attract fewer foreign students and a larger proportion of women than their physics counterparts.

Enrollments in physics degree programs continue to shrink, a trend that has been sustained for the better part of the 1990's. Degree production at the bachelor's and master's levels has been falling for a number of years and the number of PhDs conferred, currently relatively stable, will also begin to fall sharply in the next year or two. This decline in students pursing physics degrees is partly the result of broad economic and political changes over the last decade that have had a major impact on the job market for physicists and related scientists.

The Education and Employment Statistics Division conducts the Survey of Enrollments and Degrees each fall, contacting all degree-granting physics and astronomy

departments in the US. Figures pertaining to the number of degrees conferred by a department the previous academic year as well as the current year's undergraduate and graduate enrollments make up the core questions of the survey. The aggregate data are used to extend long-standing trends pertaining to the physics and astronomy community.

This year's survey of all degree-granting physics departments had a response rate of 99% (see **Table 1**). Estimates were developed for the non-responding departments based on information they supplied in previous years, and are reflected in the data presented in this summary.

Table 1. Departments by highest physics degree offered, 1996-97

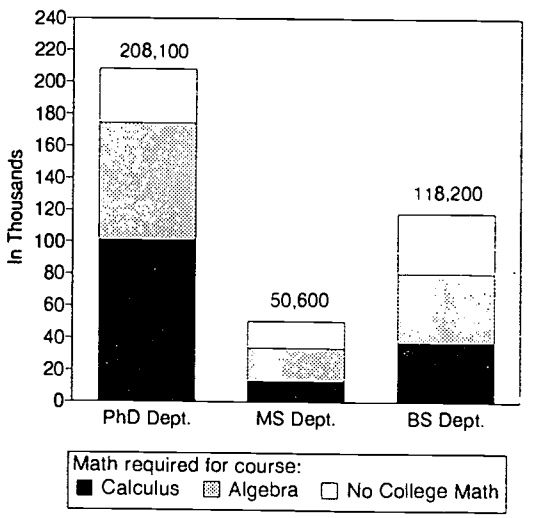
	Number of Depts	Percent Responding
PhD-granting	184	98
Master's-granting	77	91
Bachelor's-granting	502	100
Total	763	99%

The appendix tables of this report list recent annual degree production and enrollment totals for physics and astronomy departments. The actual school-by-school figures that form the basis for the aggregates reported here are available in two separate publications, the **Roster of Physics Departments** with **Enrollment and Degree Data** and the **Roster of Astronomy Departments with Enrollment and Degree Data**. These reports are available upon request at no cost.

INTRODUCTORY ENROLLMENTS

During a period in which physics degree programs are experiencing substantial declines, enrollment in college-level introductory physics courses is very stable. During the 1995-96 academic year about 377,000 students took an introductory physics course at one of the degree-granting physics departments in the US (see **Figure 1**). Less than 2% of these students will declare physics as their major and about 1% will eventually receive a physics bachelor's degree. This demand for introductory instruction underscores the crucial role played by physics departments in providing service courses to the non-physics major.

Figure 1. Introductory physics enrollments by math background required for course and type of department attended, academic year 1995-96.



Note: Figure only includes departments with degree-granting physics programs.

Forty percent of the students who took introductory physics enrolled in a course requiring knowledge of calculus. Another 37% of the students enrolled in a course that was taught at a level requiring some background in algebra. The remaining 23% of the introductory physics students were in courses that required no college math.

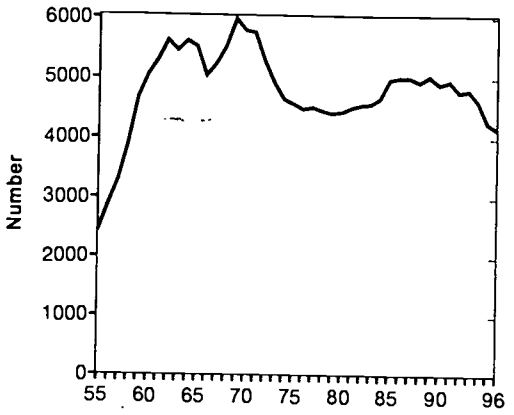
UNDERGRADUATE ENROLLMENTS AND DEGREES

Physics bachelor's production continued to decline for the class of 1996, down 2.5% from last year and 17% from a recent high in 1989 (see **Figure 2**). The number of degrees conferred in the 1995-96 academic year was 4165. It has been four decades since degree production was at this level.

This seven-year decline in the number of physics bachelor's being conferred is occurring at a time when overall bachelor's degree production in the US, for all disciplines combined, has increased 16% to 1,186,000. Physics bachelor's degrees, which only comprised 0.35% of the total bachelor's degrees in the class of 1996, are not only declining in number but also in the proportion of all bachelor's degrees conferred each year.

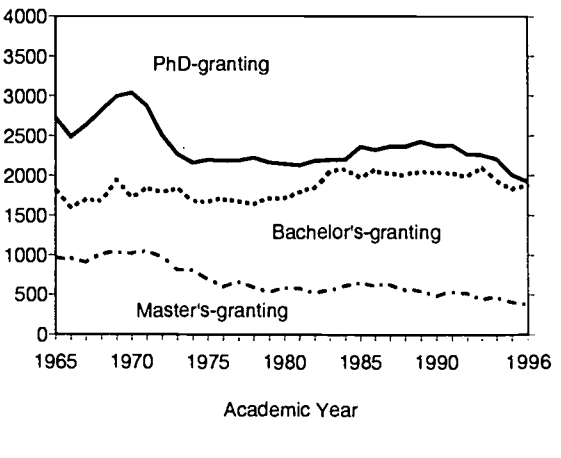
This recent decline in undergraduate physics degrees has not been uniform across the different types of physics departments. Departments that have graduate physics programs are experiencing the greatest declines in undergraduate majors (see **Figure 3**). This is similar to the declining degree production

Figure 2. Physics bachelor's production in the US, 1955 - 1996.



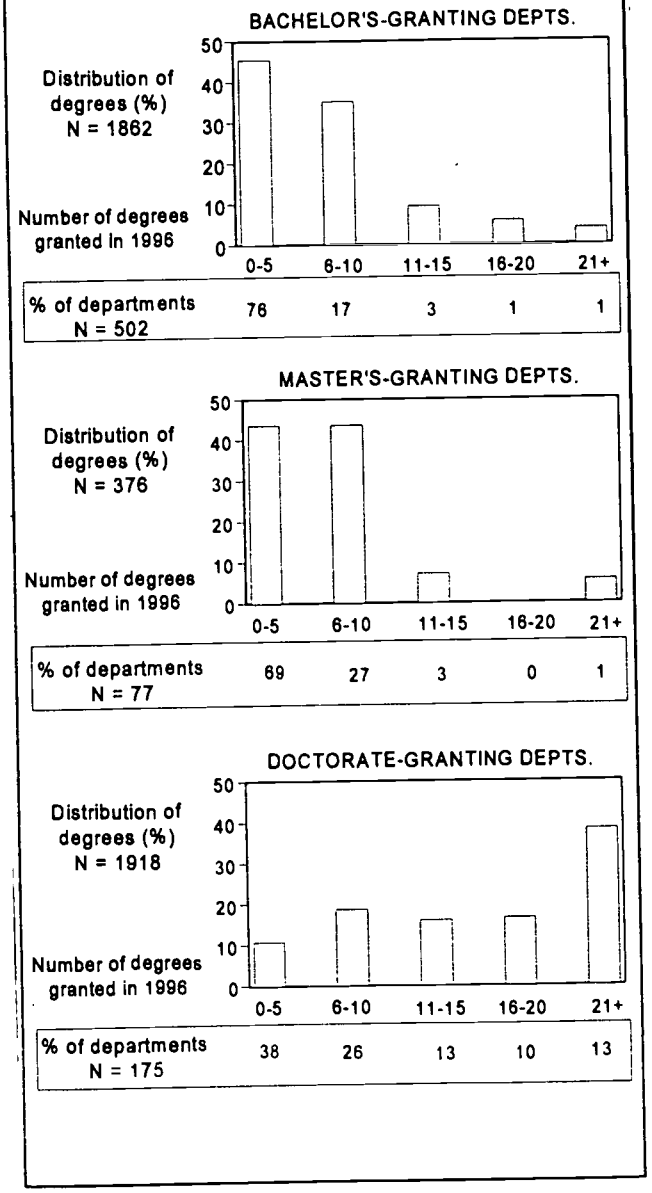
patterns of the early 1970's, when departments with doctoral programs also experienced the bulk of the declines. In both cases, the declines coincided with widespread reports of poor job prospects for graduating physicists. Figures for junior-level enrollments indicate that both the current decline and its concentration at departments with graduate programs will continue for at least two more years.

Figure 3. Physics bachelor's degrees awarded by department type, 1965-1996.



Departments with physics doctoral programs represent less than a quarter of all departments that offer a physics bachelor's degree, but produced almost half (46%) of such degrees conferred in the class of 1996 (see **Figure 4**).

Figure 4. Distribution of bachelor's degrees by type of department and number of degrees granted, class of 1996.



These doctoral departments average about 11 physics bachelor's per year, with 38% of their graduates coming from departments with class sizes of 21 or more. In contrast, departments which are only bachelor's-granting average just four degrees per department, with over three-fourths coming from departments with class sizes of five or fewer bachelor's.

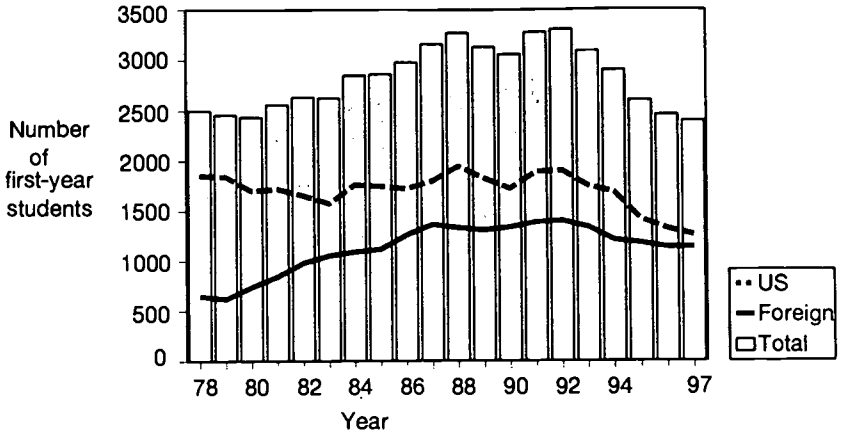
GRADUATE ENROLLMENTS

First-year graduate physics enrollments have declined for the fifth consecutive year. In 1997 enrollments dropped 2% from the previous year to 2404, with a cumulative decline of 27% since 1992. These declines are occurring at both the master's- and doctorate-granting departments.

Although this drop in first-year students has taken place among both the US and foreign students, the greater declines have been experienced within the US component (see **Figure 5**). Since 1992, the decline in the number of incoming US students has been 34%, whereas for foreign students the figure has been only 19%. Foreign citizens comprised 47% of the first-year physics enrollments in 1997, the largest proportion ever seen in this report series.

Total graduate student enrollment for the academic year 1996-97 was 11,786, declining 6% from the previous years' total, with an overall decline of 19% from the recent high five years ago. As noted earlier, these large and sustained drops in enrollments will result in significant declines in degree production in coming years.

Figure 5. First-year US and foreign graduate physics students, 1978 to 1997.



Note: Questionnaire wording changes after 1994 may slightly raise estimates of foreign citizen totals.

MASTERS: DEGREES AND PROGRAMS

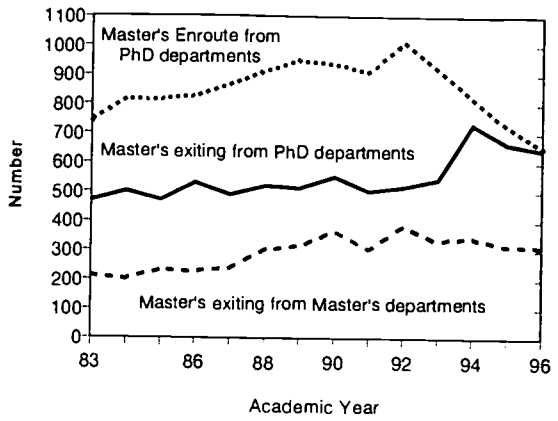
Graduate study in physics has traditionally focused most of its attention on the production of PhDs. Following a period of poor employment prospects for physics PhD recipients, and the subsequent decline in doctoral enrollments, there has been heightened interest in master's programs. In order to achieve a better understanding of these programs, this year's survey asked departments for specific details about their master's degree options and their participants. These master's degrees can be divided into three categories:

- Master's Enroute - An interim degree earned at a doctoral-granting department by a student in pursuit of a PhD.
- Professional Master's - earned as the intended final degree from a department that offers a specific physics master's program.
- Terminal Master's - awarded to a student terminating his or her doctoral studies short of a PhD.

All told, the 184 doctoral and 77 master's departments conferred 1,614 physics master's degrees on the class of 1996. Of these, 655 Master's Enroute degrees were conferred to students continuing their doctoral studies at the same department. This represents a decline of 10% from the previous year and 35% over the past four years (see **Figure 6**). Although not all doctoral candidates receive this interim degree, this trend also underscores the impending drop in PhD production.

The distinction between the remaining two types of master's degrees is not always easily discernible. The type of program available at a particular department and student intentions both come into play. This analysis first takes into consideration each department's self-classification of its own degree options.

Figure 6. Master's degrees conferred by type of degree and department, 1983-1996.



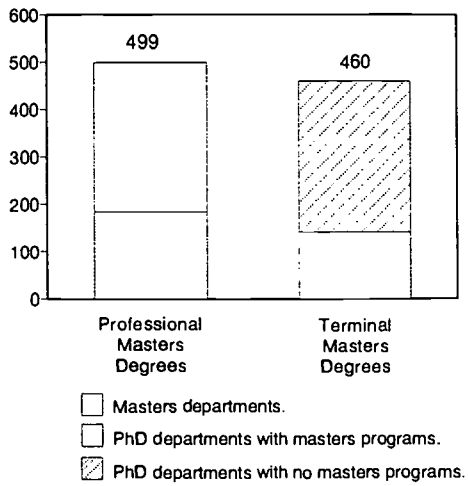
Departments which offer a doctorate in physics may or may not provide a degree option for students who aim to only go as high as a master's degree. Our survey showed that over half (58%) of the PhD departments do not offer a master's track in which an incoming student may enroll. Consequently, all exiting master's degree recipients from these departments originally enrolled in a doctoral program and so by the departments' own definition earned a Terminal Master's degree. Of course, some of these students could have actually intended from the onset to stop at the master's, but didn't make these intentions known to the department.

The remaining 42% of the doctoral-granting departments offer their entering students the option of enrolling in a Master's or a Doctoral program. These departments indicated that the students receiving Professional Master's degrees outnumbered those leaving with a Terminal Master's by about 4 to 3 in the class of 1996 (see **Figure** 7).

Although professional master's programs can be found at a wide variety of departments, the larger and more highly ranked PhD programs were less likely to offer a professional master's track than their smaller, less-renowned counterparts. Moreover, only 10% of the departments without a professional master's program intended to initiate one in the future, and only half of these could give a projected starting date.

In addition to some doctoral departments which offer an option to pursue a Master's degree, Professional Master's are granted by departments that offer the master's as the highest physics degree and is the only degree option available to their graduates. Some of these master's recipients may choose to continue with their graduate studies by transferring to a department that offers a PhD, and indeed, some master's program curricula are designed with the possibility of departmental transfer in mind. But such transferring is far from automatic, and the fact

Figure 7. Terminal and professional masters degrees by type of department, class of 1996.



that the end point of the initial course of study was the master's degree, requires that we classify all graduates from these master's departments as Professional Master's recipients.

Differences in gender and citizenship, though relatively small, do appear between the two types of master's degrees, with slightly more women and foreign citizens among the Terminal Master's recipients than among the Professional Master's (see **Table 2**).

Possibly a result of the poor job market for new doctoral recipients in recent years, increased attention has been paid to Professional Master's degrees as a potentially more marketable degree alternative, especially in industry. The use of internships, co-ops and interdisciplinary studies have been cited as ways to enhance the employment value of a degree recipient. As a result, departments were asked about specific degree options available through their Master's programs.

Surprisingly, only 15% of departments with the master's as their highest degree had any students participating in an internship or co-op during the past few years. This figure was even lower (4%) for programs at PhD-granting departments (see **Table 3**). One reason for these low figures lies in the difficulty departments encounter finding industrial companies or government organizations that wish to participate in the programs. The especially low numbers at PhD departments may also derive from their greater focus on traditional academic and research endeavors rather than applied work.

Table 2. Characteristics of master's degree* recipients, class of 1995-96.

		Professional Master's %	Terminal Master's %
Gender	Male	85	79
	Female	15	21
Citizenship	US	67	63
	Foreign	33	37

* Data concerning master's enroute degrees are not included in this table.

Table 3. Departments with students receiving interdisciplinary degrees or taking internship or co-ops during the past few years.

	PhD departments with professional master's programs %	Master's-only departments %	Total for departments with a master's program %
Joint degrees	13	8	10
Co-ops / Internships	4	15	9

Still another explanation for the small number of internships may be that many students are already working. Master's students are more likely than PhD students to be enrolled on a part-time basis and to attend classes only in the evening, and are less likely to receive university support. This is especially true at the master's-only departments where 24% of the departments indicated that the majority of their students attended classes only in the evening. In many cases this is to accommodate students who are employed full-time during the day.

The proportion of departments that had Professional Master's recipients receiving interdisciplinary degrees was also low. Only 1 in 10 departments offering a Professional Master's program had any degree recipients involved in an interdisciplinary degree. Where this did occur, engineering, computer science and mathematics were the disciplines most frequently cited. In these few departments where internships, co-ops, or joint degrees were available, it was rare that more than 20% of the students actually participated in such a program. In the end, remarkably few master's students emerge with one of these employment-enhancing entries on their resumes.

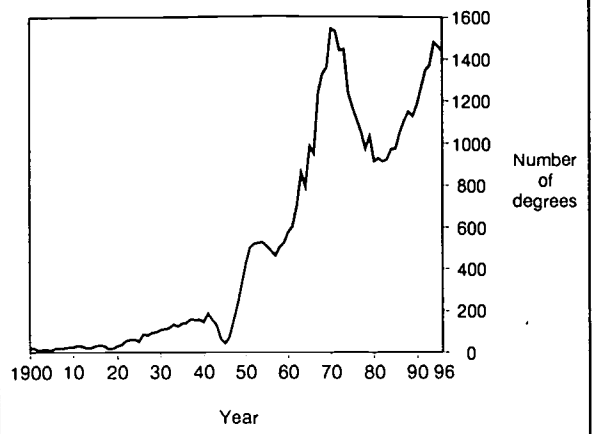
Many of the departments with active Professional Master's programs were pleased with how their programs had progressed so far. Although some degree recipients obtained permanent employment with the organizations for whom they had their co-op, departments indicated non-local industry as the leading employer of their master's program degree recipients. The work activities for these new hires included research and development as well as programming and teaching. Although Professional Master's Programs tend to be employment orientated, some departments indicated that many of their students chose to continue their education and pursue a PhD.

Finally, departments with established programs were asked whether they expected their master's program to grow over the next three years. In contrast to the earlier finding that few departments without such programs had plans to initiate one, the vast majority of both department types expected their programs to remain relatively unchanged or to grow in size. The programs at doctorate departments were more optimistic, with 41% expecting their programs to increase in size while only 28% of the master's departments anticipated future growth. Few departments expected their programs to shrink, although more of the master's-only departments anticipated such declines.

PHDs

The number of physics PhDs conferred fell slightly for the second consecutive year (see **Figure 8**). The class of 1996 totaled 1,438 degrees, down 3% from the recent high two years ago. This anticipated downturn follows 15 years of steady growth in the number of doctorates conferred. The majority of that growth resulted from an increase in the number of foreign students (mostly Chinese) enrolling in US physics doctorate programs (see **Figure 5**). Forty-eight percent of this year's doctorates were granted to foreign citizens (counting both permanent residents and those with temporary visas), a proportion that has been relatively stable for the last four years.

Figure 8. Number of physics PhDs conferred in the United States,1900 to 1996.



Sources: ACE (1900-19), NAS (1920-61), AIP (1962-96)

WOMEN AND MINORITIES

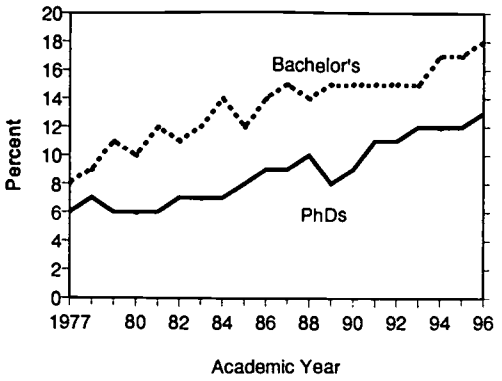
The proportion of women earning degrees in physics continues to slowly increase (see **Figure 9**). Although still less than other scientific disciplines, the percentage of women at both the bachelor's and doctorate levels has more than doubled during the past two decades. During the last three years, the proportion of women entering doctoral-departments as first-year students has remained stable at 17% with foreign women accounting for about half of these enrollments.

The representation of minorities among the physics degree recipient populations has not changed in recent years (see **Table 4**). Hispanic and African-American students continue to be underrepresented, and Asian-Americans overrepresented, at all degree levels. Bachelor's and master's degrees granted to African-Americans are concentrated at a limited number of departments. Sixty-six percent of the bachelor's degrees and 46% of the master's awarded to African-Americans in the class of 1996 were conferred at one of the nation's 33 historically black colleges and universities that offer at least a bachelor's in physics.

Table 4. Number and percent of physics degrees granted to US citizens by minority / ethnic group status, class of 1996.

	Bachelor's		Terminal/Professional Master's		Doctorates	
Ethnic group	Number	Percent	Number	Percent	Number	Percent
White	3288	86	533	89	674	90
African-American	211	6	26	4	9	1
Asian-American	166	4	14	2	40	5
Hispanic	96	2	16	3	17	2
Other	82	2	13	2	15	2
Total US Citizens	3843	100%	602	100%	755	100%

Figure 9. Percent of bachelor's degrees and doctorates in physics granted to women, class of 1977-1996.



Note: A form change occured in 1994 resulting in a more accurate representation of women among physics bachelors. Some of the increase in 1994 may be a result of that change.

Table 5. Number of degree-granting astronomy departments by highest astronomy degree offered, academic year 1996-97.

Department type	Combined with physics	Separate Astronomy	Total
PhD-granting	13	29	42
Master's-granting	2	2	4
Bachelor's-granting	21	5	26
Total	36	36	72

ASTRONOMY

The 72 degree-granting astronomy departments fall into two distinct groups: half are stand-alone departments devoted strictly to astronomy and half are administered in combination with a physics department (see **Table 5**). The separate astronomy departments are commonly found at larger research universities, with the majority offering astronomy degrees up to the doctorate level. It should be noted that students can receive degrees in astrophysics from physics departments as well as from combined or stand-alone astronomy departments. The degree data given in this section pertain only to the latter. Astrophysics degrees granted by the physics departments are included in the physics degree totals presented earlier.

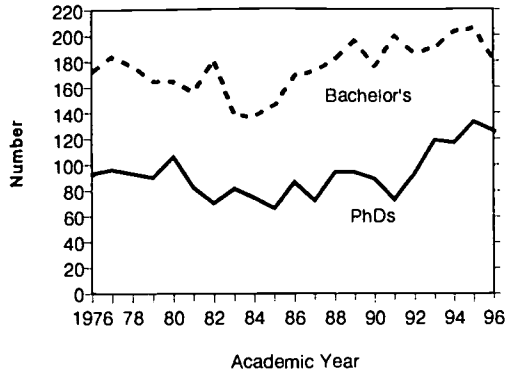
Approximately 156,000 students took an introductory astronomy course at a degree-granting physics or astronomy department during the 1995-96 academic year (see **Table 6**). Consistent with past years, two-thirds of these enrollments were at departments where an astronomy major was not available.

Table 6. Introductory astronomy course enrollments by department type, academic year 1995-96.

	Bachelor's-granting	Master's-granting	Doctoral-granting	Total
Astronomy & combined departments	8,506	2,500	39,600	50,600
Physics departments	43,800	21,800	39,800	105,400
Total	52,300	24,300	79,400	156,000

Note: Table only includes enrollments at degree-granting physics and astronomy departments.

Figure 10. Astronomy bachelor's degrees and doctorates awarded in the US, 1976-1996.



Note: The astronomy doctorate totals presented here do not include astrophysics degrees conferred by physics departments. Those degrees are included among the physics totals.

Table 7. Percent of women and foreign citizens among recent astronomy degree recipients, class of 1996.

Degree	Women %	Foreign* %
Bachelor's	38	4
Professional/ Terminal Master's	41	15
PhDs	24	22

* Foreign citizens include individuals with permanent residents status as well as those with temporary visas.

Although the number of astronomy degrees conferred at both the bachelor's and doctorate level fell slightly in 1995-96 compared to the previous academic year, the overall number of students receiving these degrees has risen in recent years (see **Figure 10**). The astronomy class of 1995-96 consisted of 181 Bachelor's degrees, 44 Terminal/Professional Master's degrees and 126 Doctorates. Characteristics of astronomy degree recipients continue to differ from their physics counterparts - women have a higher representation and non US-citizens a lower representation than among the physics degree recipients (see **Table 7**). **Appendix A1** presents ten years of astronomy data at both the undergraduate and graduate levels.

APPENDIX

Table A1. Trend in astronomy enrollments* and degrees, academic years 1986 to 1997.

	Number of astronomy degrees granted				Undergraduate astronomy major enrollments		Graduate astronomy student enrollments	
Academic year	Bachelor's	Master's enroute	Terminal Master's	PhDs	Juniors	Seniors	1st year	Total
1986-87	172	37	44	72	268	255	173	755
1987-88	181	49	26	94	250	285	171	731
1988-89	196	71	22	94	213	275	169	780
1989-90	176	75	19	89	223	236	186	842
1990-91	200	65	25	73	312	284	226	914
1991-92	186	80	31	93	290	331	175	935
1992-93	190	46	56**	119	337	348	173	939
1993-94	203	73	34	117	257	388	180	901
1994-95	205	72	43	133	269	351	165	905
1995-96	181	55	44	126	272	361	149	874
1996-97					265	332	155	837

* Includes part-time students.
** Thirty-four Master's came from the Arizona Summer Science Institute for science teachers at the University of Arizona.

Table A2. Trend in physics enrollments* and degrees, academic years 1986 to 1997.

Academic year	Number of physics degrees granted			Undergraduate physics major enrollments		Graduate physics student enrollments	
	Bachelor's	Total Master's**	PhDs	Juniors	Seniors	1st year	Total
1986-87	5011	1596	1105	6592	7054	3162	12616
1987-88	4937	1733	1150	6412	7017	3274	13143
1988-89	5033	1781	1112	6390	7116	3132	13361
1989-90	4898	1857	1183	6313	7131	3059	13708
1990-91	4950	1718	1264	6445	7115	3278	14065
1991-92	4770	1918	1346	6435	7268	3306	14534
1992-93	4800	1797	1369	6287	7297	3090	14430
1993-94	4615	1899	1481	6146	7289	2902	14201
1994-95	4263	1710	1461	5620	6836	2604	13285
1995-96	4156	1614	1438	5335	6489	2462	12596
1996-97				5057	6116	2404	11786

* Includes part-time students
** Includes both Terminal / Professional Master's and Master's enroute.

Table A3. Trend in physics enrollments* and degrees by institution type, academic year 1990 to 1997.

Academic year	Number of physics degrees granted			Undergraduate physics major enrollments		Graduate physics student enrollments	
	Bachelor's	Total Master's**	PhDs	Juniors	Senior	1st year	Totals
Doctorate-granting institutions							
1990-91	2376	1414	1264	3082	3694	2782	12700
1991-92	2261	1530	1346	3057	3729	2831	13118
1992-93	2253	1463	1369	3038	3845	2688	13222
1993-94	2203	1554	1481	2920	3729	2509	13042
1994-95	2009	1390	1461	2648	3453	2209	12173
1995-96	1918	1299	1438	2461	3344	2117	11545
1996-97				2200	3133	2074	10900
Master's-granting institutions							
1990-91	541	304		800	956	496	1365
1991-92	525	388		802	938	475	1416
1992-93	448	334		719	887	405	1208
1993-94	475	345		696	930	393	1159
1994-95	420	320		610	813	395	1113
1995-96	376	315		556	703	345	1047
1996-97				530	667	330	886
Bachelor's-granting institution							
1990-91	2033			2563	2470		
1991-92	1984			2576	2601		
1992-93	2099			2530	2565		
1993-94	1937			2530	2630		
1994-95	1834			2362	2570		
1995-96	1862			2318	2442		
1996-97				2327	2316		

* Includes part-time students
** Includes both Professional / Terminal Master's and Master's Enroute.

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